A Housing Energy Management Program Report

Energy
Ontario

FIELD EVALUATION OF TWO HIGHER EFFICIENCY FURNACES AND ONE HIGHER EFFICIENCY COMBINATION BOILER AND DOMESTIC HOT WATER HEATER

INSTALLATION AND INTERIM REPORT

REPORT No. 10A

Funding for this field evaluation was provided equally by the Ministry of Municipal Affairs and Housing through funds provided by the Ministry of Energy, through the Housing Energy Management Program (H.E.M.P.), and The Consumers' Gas Company Ltd.

Prepared for
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by

THE CONSUMERS' GAS COMPANY L D.

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AUTHOR'S NOTE

The appliance name, make and model number are omitted from the text, as requested specifically by the Ministry of Municipal Affairs and Housing.

The units under field evaluation and the subject of this report are the Arkla Recouperative Gas Furnace UR Series, the York Concept 2000 High Efficiency Gas-Fired Furnace and the BGP Systems Heatmaker HW Series. Combination boiler and domestic hot water heater.

If additional information is required from the reading of this report, please contact Antonio Galati, Research and Development, Telephone Number 495-5272, Area Code 416.

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SUMMARY

As part of an on-going co-operative effort in field testing programmes, the Ontario Ministry of Municipal Affairs and Housing and the Consumers' Gas Company Ltd. have jointly undertaken, on a 50/50 shared funding basis, to test and evaluate the performance of three recently introduced high seasonal efficiency gas heating appliances.

This report gives a description of the units under evaluation, details on instrumentation adopted and evaluation procedures and reports on their installation and associated costs.

Two warm air systems are evaluated against hard reference electric plenum heaters. Direct input and output energy measurements are made on the third appliance, a combination domestic hot water and hydronic heating unit.

General information on the test sites are given in appendix.

1.0 INTRODUCTION

The Utilities and Governments have a need to remain fully informed on the newly introduced technological developments relating to high efficiency and ultra-high efficiency space conditioning appliances, the functional operation, the seasonal performance and the operating costs of such devices. It is essential that both parties have this information, so as to provide the public with accurate results, to encourage market adoption of these technologies.

To fulfill this need, it is recognized that "real world" field testing represents the most desirable method of evaluation, from a practical standpoint.

It is expected that data and operating experience gained through this and other similar field testing programmes will aid, among others, in the formulation of Governments' energy strategies and the planning and execution of various Utilities' activities.

As part of an on-going co-operative effort in such field testing programmes, the Ontario Ministry of Municipal Affairs and Housing, with funds provided by the Ministry of Energy, and The Consumers' Gas Company Ltd. have jointly undertaken, on a 50/50 shared funding basis, to test and evaluate the performance of three recently introduced, high seasonal efficiency, gas heating appliances.

The units selected are CGA approved and are currently available on the market.

2.0 OBJECTIVE

The objective of this evaluation programme is to determine the functional reliability, operational performance and potential energy savings of some recently introduced gas heating appliances, which yield Annual Fuel Utilization Efficiencies (AFUE) in the range of 83-87%, according to their manufacturers.

3.0 DESCRIPTION OF SYSTEMS UNDER EVALUATION

In this field testing programme, two high efficiency gas furnace and a high efficiency combination domestic hot water/hydronic heating boiler are under study. The appliances will be referred to as:

- Recouperative Gas Furnace
- High Efficiency Non-Condensing Gas Furnace
- Combination Boiler and Domestic Hot Water Heater

In keeping with broadening the scope of the test programme, each appliance operates on a different principle. A description follows.

3.1 RECOUPERATIVE GAS FURNACE

This unit adopts a two-stage heat exchanger design. Combustion takes place in the primary stage, which consists of a clam-shell type, sectional heat exchanger, stamped out of cold rolled aluminized steel.

To enhance the efficiency of the unit, the combustion products, prior to venting to atmosphere, are routed through a secondary heat exchanger, where they are cooled below their dew point, to recover both some sensible and latent heat. The secondary heat exchanger consists of a stainless steel clam-shell, very similar to those of the primary stage. The primary and secondary stages are connected by a manifold. As some condensation occurs in the secondary heat exchanger, drainage means are provided, for connection to a suitable drain.

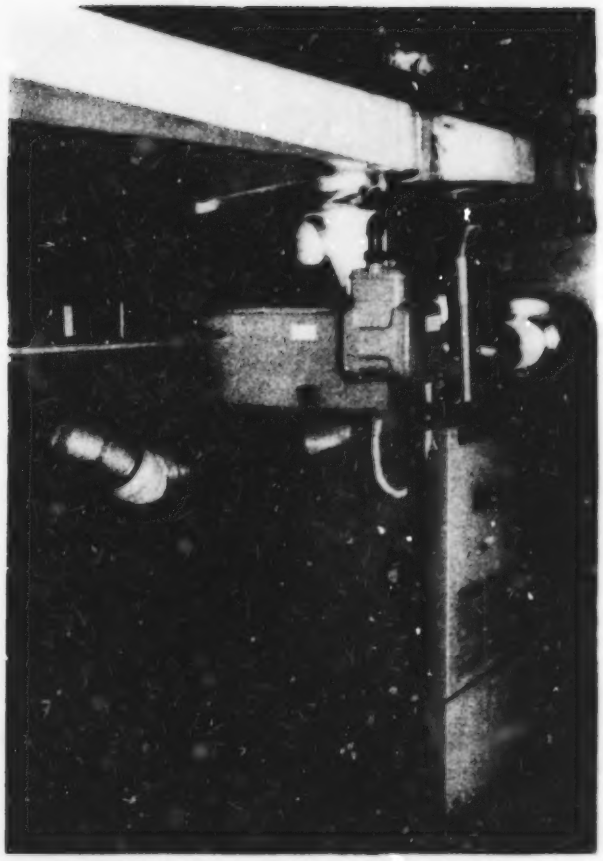
To insure proper and safe operation, the flue products are driven by a blower controlled by an electronic ignition module and pressure switches. The control system is such that, prior to firing, the heat exchangers are pre-purged and air flow must be established and proven. In the event of insufficient exhaust flow during the burner-on cycle, gas flow is interrupted for safety. If automatic relighting attempts fail, the unit locks-out and service intervention is needed.

The unit is shown in Figure 1.

3.2 HIGH EFFICIENCY NON-CONDENSING GAS FURNACE

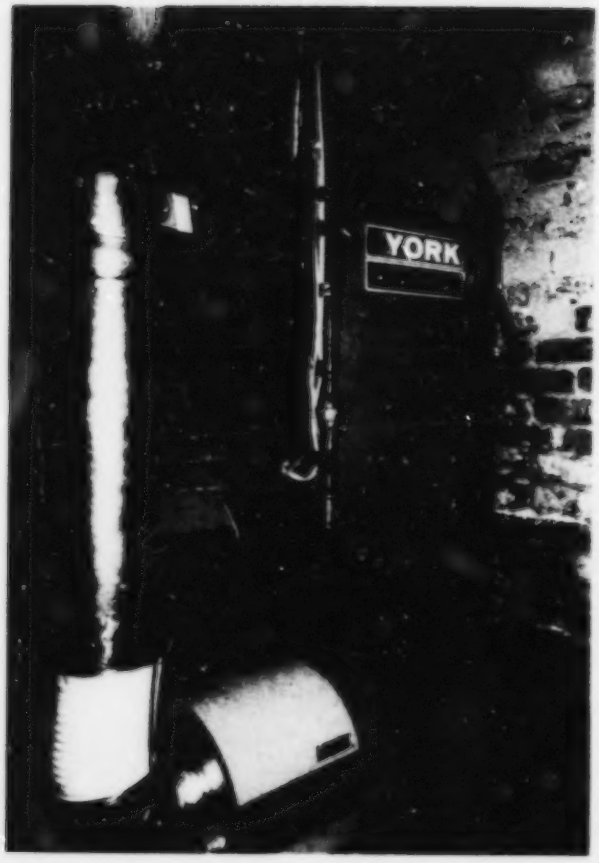
Shown in Figure 2, the test unit is an example of a high efficiency, non-condensing, gas-fired furnace. It represents an attempt to maximize combustion efficiency within the limits of a non-condensing regime and to optimize the seasonal efficiency (quoted at 83%), while maintaining basic design features as conventional as possible.

The increased steady state thermal efficiency (quoted at 85%) is achieved by reducing the amount of excess air as much as possible, compatibly with good combustion, and by lowering the exit temperature of flue gases to 150°C, down from approximately 260°C of conventional furnaces, according to the manufacturer. Both aims are reached by limiting the size of secondary air inlets at the burners' end and by providing increased heat transfer surface and sufficient flow restriction, to prolong the residence time of the combustion products inside the heat exchangers.



RECOUPERATIVE GAS FURNACE

FIG. 1



HIGH EFFICIENCY NON-CONDENSING GAS FURNACE

FIG. 2

As with the recouperative unit, the heat exchanger system consists of a primary and a secondary stage, both made up of conventional, adjacent, clam-shell type heat exchangers.

Again, combustion takes place in the primary heat exchanger section which consists of two cold rolled steel clam-shells. Through an insulated manifold, the combustion products are routed into a third, aluminized steel, unfired clam-shell, where they release additional sensible heat for improved efficiency, prior to venting.

Flue products flow is induced by means of an exhaust fan, controlled to provide pre and post-purge of the system. Common to other high efficiency appliances, the fan also allows positive control of excess and combustion air levels, for optimum thermal efficiency. According to the manufacturer, the design is such that no warm air from the conditioned space escapes during the off-cycle, due to the combined effect of a tortuous gas side path and the flow resistance of the exhaust fan, which essentially negates the onset of exfiltration air flow and related thermal losses.

These same reasons mandate the use of electronic ignition (intermittent pilot type) as a continuous pilot would starve. The resulting effect is a manufacturer claimed seasonal efficiency of 83%.

3.3 COMBINATION BOILER AND DOMESTIC HOT WATER HEATER

The test appliance is an integrated gas-fired unit capable of providing both instantaneous domestic hot water and central space heating. The design consists of a well insulated 18 USG storage tank and of an advanced power burner module, which transfers heat to a coil, through which stored water is pumped. Water temperature in the tank is constantly maintained at 60°C or higher via low and high limit switches, which control the burner operation.

The tank is well insulated, but losses may still occur through fittings and copper tube connections, given the high stored water temperature.

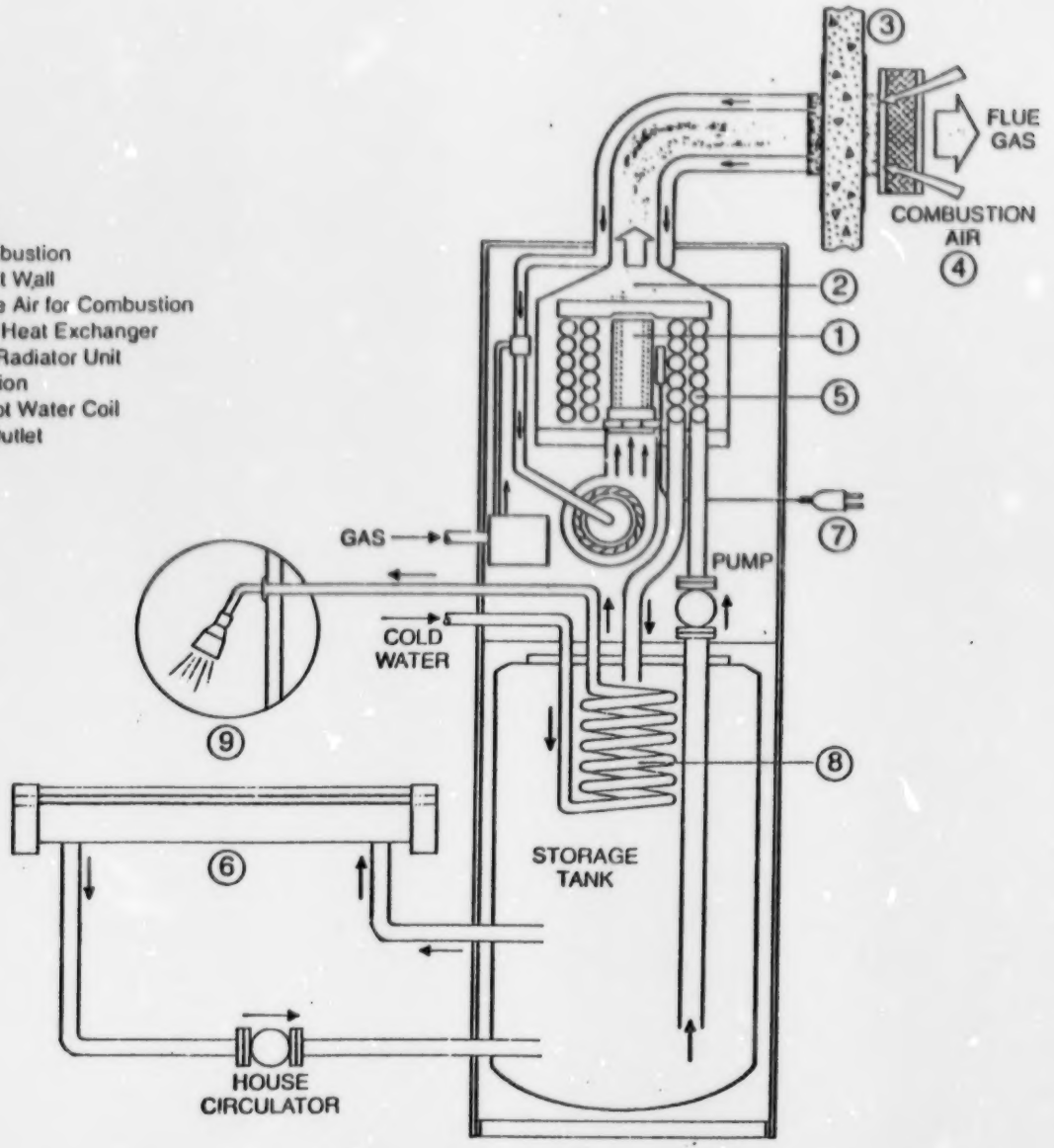
Space heating water is drawn from the storage tank as required by the heating demand. There is sufficient capacity in reserve to satisfy most domestic hot water requirements, according to the manufacturer.

Domestic hot water is heated indirectly, through a low-mass copper coil immersed in the storage tank. The low mass assures fast response, while recovery periods are eliminated because the stored water never falls below 60°C and in fact can be as high as 80°C.

Ignition is electronic and the combustion is sealed. Combustion air is drawn from outside through a pipe concentric to the flue. This feature allows to recover some of the exhaust heat. The combined effect of the various design features should result in a AFUE of 82 to 87% depending on input, according to manufacturer's claims.

This system is schematically illustrated in Figure 3.

1. Gas Burner
2. Sealed Combustion
3. Outside Vent Wall
4. Cold Outside Air for Combustion
5. Copper Coil Heat Exchanger
6. Baseboard/Radiator Unit
7. Electric Ignition
8. Domestic Hot Water Coil
9. Hot Water Outlet



COMBINATION BOILER AND DOMESTIC HOT WATER HEATER - SCHEMATIC

FIG. 3

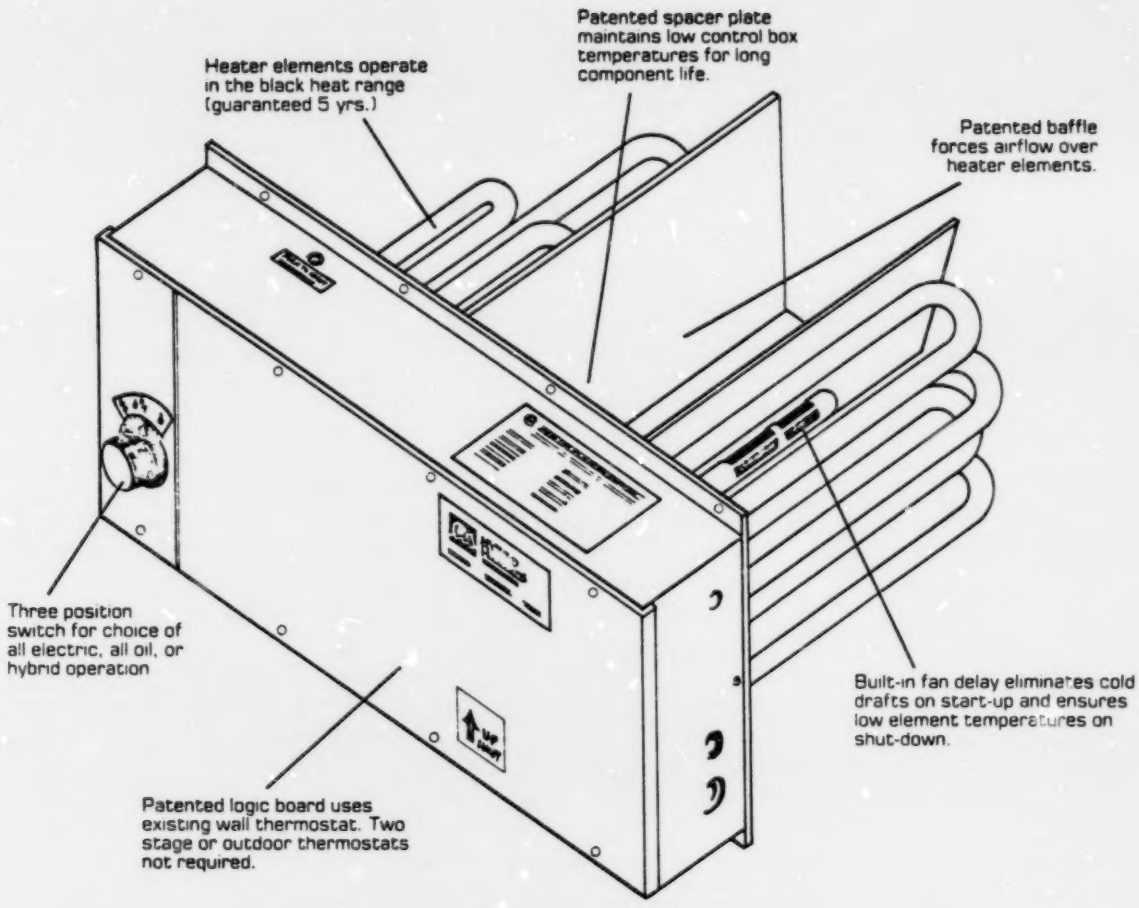
4.0 FIELD TESTING AND EVALUATION PROCEDURE

4.1 WARM AIR SYSTEMS - RECOUPERATIVE AND NON-CONDENSING FURNACES

In order to assess the functional performance of the units, while providing the most accurate and direct measure of their seasonal efficiency from a practical standpoint, it was decided to operate the two gas furnaces in parallel with two electric plenum heaters, in a daily manual changeover procedure.

The plenum heaters, shown in Figure 4, have finned tube type heating elements, operating in the "black heat" range (ie. never become incandescent) for a claimed long element life. They incorporate a control circuit board, which, through a bimetallic blower and high limit switch, interfaces with the gas furnace, so that the same circulating air blower and duct system can be used for both heating modes.

The capacity of the electric heaters was selected as close as possible to the output of the gas units, in order to minimize differences in flow rate and temperature rise of the circulating air, under the two heating modes.


Heater elements operate in the black heat range (guaranteed 5 yrs.)
Patented spacer plate maintains low control box temperatures for long component life.
Patented baffle forces airflow over heater elements.
Three position switch for choice of all electric, all oil, or hybrid operation
Built-in fan delay eliminates cold drafts on start-up and ensures low element temperatures on shut-down.
Patented logic board uses existing wall thermostat. Two stage or outdoor thermostats not required.

ELECTRIC PLENUM HEATER

FIG. 4

Changeover between heating modes is accomplished simply by turning a switch in the appropriate position (electric or gas). This action will be conducted at the same time each day and the readings/data will be recorded at this time also.

The fairly high frequency of changeover (daily rather than weekly or monthly) is intended to average out as much as possible differences in operating conditions that inevitably will occur in a field test type of environment. For example, while variables like climatological conditions cannot be controlled, for a given outdoor temperature or number of degree days, it is totally feasible for a test site to require less energy in a sunny day, than under cloudy or windy conditions, to maintain the inside temperature at a given value.

Other difficult to control variables include people's living habits, which can affect heating load demand under otherwise identical conditions.

Based on the fact that the average rate of heat loss (or average space heating consumption rate) and the difference between inside and mean outside temperature are linearly dependent, the two quantities can be plotted to determine the slope of the line representing their relationship and the balance point temperature, at which the rate of heat loss is zero. Assuming that the inside temperature is maintained constant, the rate of average daily heat loss can be plotted against daily accumulated degree days with equally valid results.

Since the electric plenum heaters can be assumed to be 100% efficient in converting electric energy into thermal energy, a comparison of the energy consumption of the gas furnaces against the energy consumption of the plenum heaters will give a measure of the seasonal efficiency of the gas units. In particular, the seasonal efficiency will be given by the ratio of the slope for the gas unit over that for the electric plenum heater.

4.2 HYDRONIC SYSTEM - COMBINATION UNIT

To arrive at a seasonal efficiency measure of the hydronic heating/domestic hot water integrated appliance, it was decided to continuously monitor the energy balance between input and outputs from the system. This can be easily achieved by metering the gas consumption to arrive at the energy input and by comparing it to the thermal energy content of the water flowing in the hydronic heating and domestic hot water circuits over a given period of time. The seasonal efficiency measurement is direct and given by the ratio of the cumulative output over the input energy figures.

Testing of this unit will continue through the summer months, when its efficiency under domestic water heater mode only will be measured. In turn, this will allow to easily monitor the performance of the unit under the two distinct modes of which it is capable.

4.3 INSTRUMENTATION

In order to collect necessary data to measure the seasonal efficiency of the appliances under test, the three sites were equipped with the following monitoring instrumentation:

GAS SUBMETERS - Canadian Meter Co. type A-225 with digital cubic feet per minute read-out, for higher resolution. To measure gas input to individual units.

ELECTRIC SUBMETERS - Sangamo Electric Ltd. Two 100A, kW·h meters. To submeter energy input to electric plenum heaters and power consumption to run the circulating air blowers and other furnace components.

DEGREE DAY RECORDERS - Hidy Brown Recorders Company
Hidy degree day recorders, single dial model. Monitor the number of degree-days over the heating season, for degree- day/energy input correlation analysis.

ELAPSED TIME INDICATORS - Hecon of Canada Ltd. type 406, code number G0406416. To monitor the duration of each heating cycle.

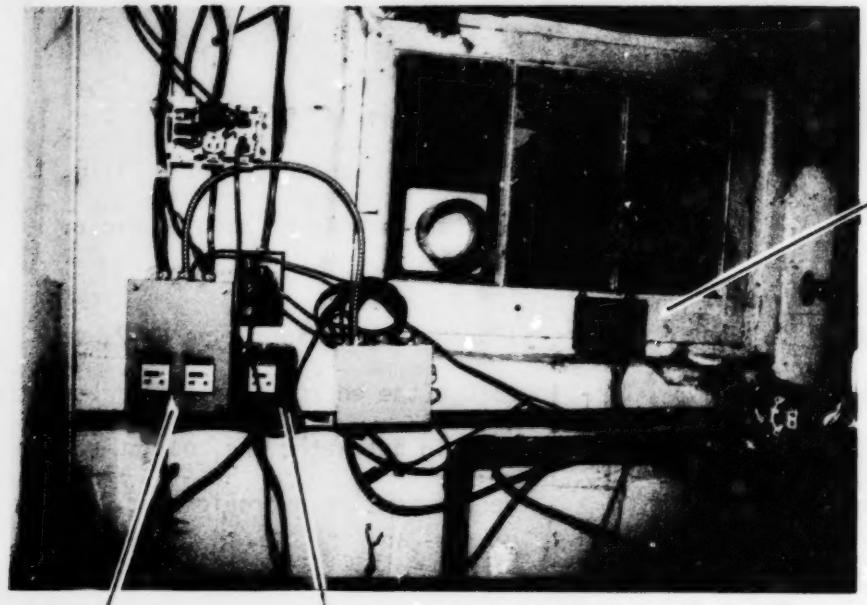
EVENT COUNTERS - Hecon of Canada Ltd. electronic totalizing counters, series G0716, to count the number of heating cycle.

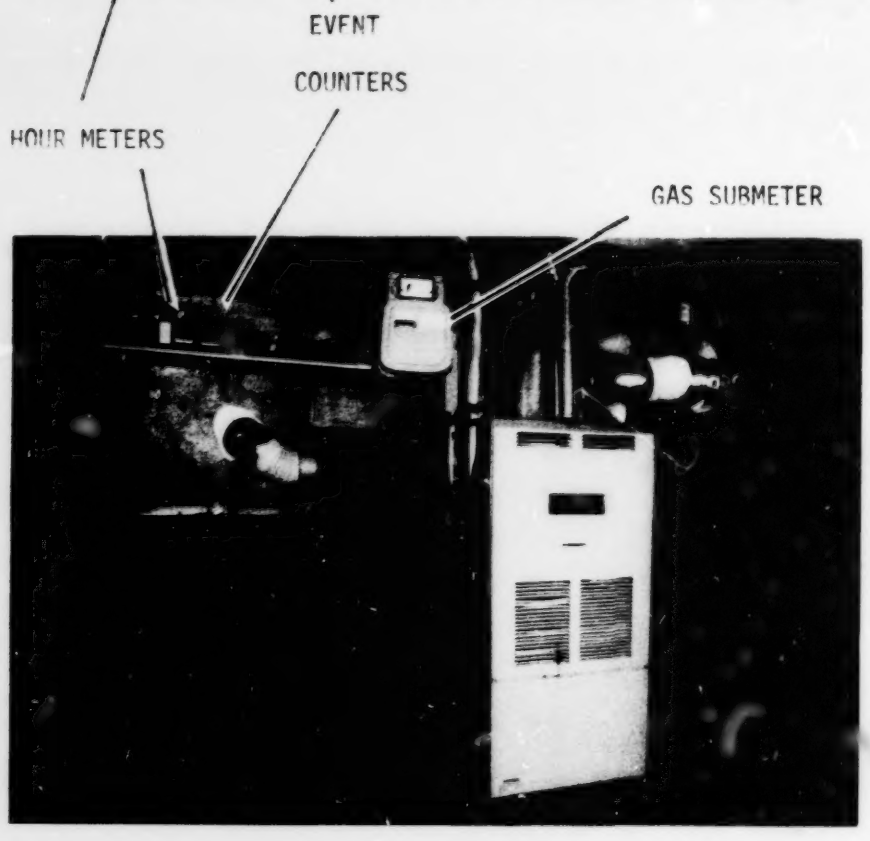
BTU METERS (Hydronic site only) - Wilgood Corporation, type HM-2, to measure the energy output from both the domestic hot water and heating modes of the combination hydronic unit.

In addition, a Furnace Efficiency Meter model O from RAB Dedesco Ltd. allows for easy on site flue gas analysis and efficiency measurements, even from condensing systems.

Typical instrumentation set-up is shown in Figure 5, although the electric submeters are not visible.

Data are read and recorded daily at a predetermined time (24 hour cycle).





TYPICAL INSTRUMENTATION SET-UP

FIG. 5

5.0 INSTALLATION

The test sites selected are the residences of company employees. Daily changeover between systems and data collection is carried out by the residents.

The three houses, representative of model, size and construction type of most common households, are shown in Figures 6, 7 and 8 and are designated as Test Site "A", Test Site "B" and Test Site "C".

Test Site "A" hosts the recouperative gas furnace, Test Site "B" the high efficiency non-condensing gas furnace, while the combination boiler and domestic hot water heater is installed in Test Site "C".

The "Homeowner Questionnaires" in Appendix "A" contain additional information on the test sites, heating systems and demographic data.

The two gas furnaces are representative of current designs as far as weight, dimensions and electric hook-up requirements. Venting of both units differs from common practice, in that they do not need a chimney, but can be vented through an external wall, as shown in Figure 9 and 10. If an external wall is not available, venting can be effected through a chimney, by extending through it the vent line, according to manufacturer's installation instructions and at a cost premium of about 300 dollars.

Venting should also be done in conformity to local codes. In our case the vent outlets should have been positioned 0.9 m (3 ft.) above

TEST SITE "A" - RECOUPERATIVE GAS FURNACE

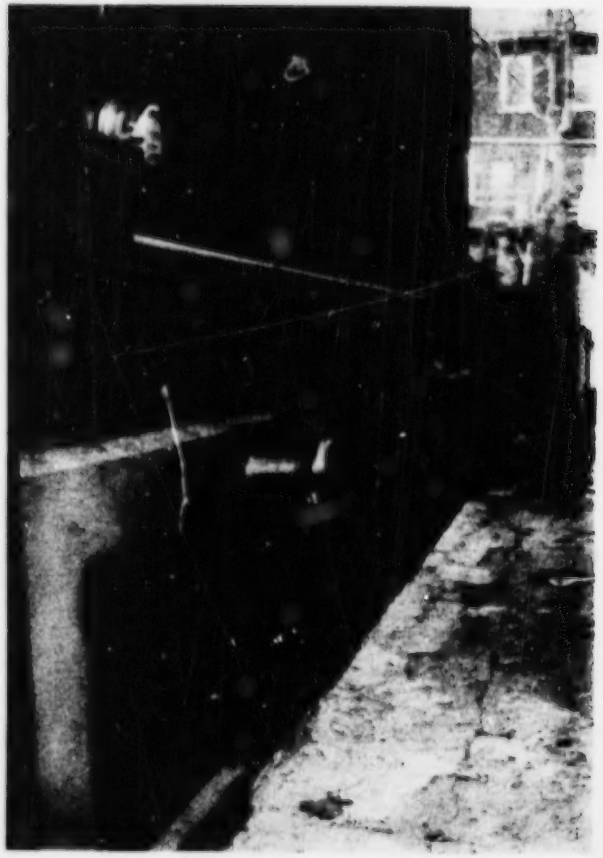
FIG. 6

TEST SITE "B" - HIGH EFFICIENCY NON-CONDENSING GAS FURNACE

FIG. 7

TEST SITE "C" - COMBINATION BOILER AND DOMESTIC HOT WATER HEATER

FIG. 8



VENTING - TEST SITE "A"
FIG. 9

VENTING - TEST SITE "B"
FIG. 10

ground and 0.9 m (3 ft.) away from any window or other openings. However, we did not comply with applicable regulations, since both windows visible in Figure 9 and 10 are permanently closed. The vent in Figure 10 was deliberately left close to the ground (simulating an improper installation), to check for potential problems in case of a heavy snow fall.

The gas furnaces in Test Sites "A" and "B" are tested against plenum heaters of 17.5 kW (63 MJ/h) and 15 kW (54 MJ/h) respectively. The difference is ascribed to specific heating load requirements. The electrical services were upgraded to 200 A, to avoid any problems with overloading.

Figure 11 shows the installed hydronic heating, domestic hot water, combination appliance. The heat loss of the site was determined to be about 63 MJ/h, however, a unit with a larger output was selected to accommodate for concurrent domestic hot water and heating demands without penalizing either mode. As already mentioned, the unit under test has an input of 29.3 kW (105.5 MJ/h), with a rated Annual Fuel Utilization Efficiency (AFUE) of 84%.

Except for attendant equipment necessary for our test (eg. BTU meters) installation was fairly typical of hydronic systems and should not present particular difficulties for any heating contractor. A deviation from normal practice is having to cut or drill a hole in an external wall for the 127 mm (5") diameter inlet/outlet concentric venting system. Suitable drills are available to easily perform that task, even through concrete blocks, minimizing impact on labour time and costs.

COMBINATION BOILER AND DOMESTIC HOT WATER HEATER - VIEW OF INSTALLED UNIT

FIG. 11

5.1 INSTALLATION COSTS

5.1.1 Recouperative Gas Furnace

Appliance	1 447
Contractor (Labour)	700
Degree Day Recorder	1 203
Counters	607
Miscellaneous Supplies	135
Humidifier	115
Plenum Heater	900
Plenum Heater Connection	187
Electric Service (Parts)	1 112
Electric Service (Labour)	518
Total (Including Labour)	6 924

5.1.2 High Efficiency Non-Condensing Furnace

Appliance	1 433
Contractor (Labour)	700
Degree Day Recorder	1 203
Counters	607
Miscellaneous Supplies	100
Humidifier (Installed)	236
Plenum Heater	900
Plenum Heater Connection	260
Electric Service (Parts)	1 196
Electric Service (Labour)	518
Total (Including Labour)	7 153

5.1.3 Combination Boiler and Domestic Hot Water Heater

Appliance	2 250
Contractor (Labour)	874
Tempering Valve	36
Solenoid Valve	314
Labour For Above	227
Air Bleeders and Pipe Insulation Inst.	203
Degree Day Recorder	1 203
Miscellaneous Supplies	137
Total (Including Labour)	5 244

The above costs relate to set-up for experimental purposes and include appliances and attendant instrumentation, submeters, etc. as required for test purposes.

A consumer considering the substitution of his heating system with one of the above, on the average, may expect to spend the following:

- Recouperative and Non-Condensing
  High Efficiency Furnaces $2 000 - 2 200

- Combination Boiler and
  Domestic Hot Water Heater $3 400 - 3 600

The above figures are ranges of quotations obtained by authorized heating contractors and include removal of old appliance and installation of new one, with necessary sheet metal work and wiring.

Prices assume that venting can be effected through an external wall. If this is not viable, the vent line is run up the existing chimney at an additional cost of $100 - 200.

Price ranges for replacement with other available gas heating systems were also obtained (input range 23.4 - 29.3 kW):

Furnaces:

- Conventional, Standing Pilot (Includes Chimney Liner)	$1 700 - 1 800
- High Efficiency, Non-Condensing	$2 000 - 2 200
- High Efficiency, Condensing	$2 500 - 2 900

Boilers:

- Conventional, Standing Pilot (Includes Chimney Liner)	$2 400 - 2 600
- High Efficiency, Non-Condensing	$3 000 - 3 200
- High Efficiency, Condensing	$4 800 - 5 500

Some boiler manufacturers offer an optional indirectly heated domestic hot water tank. Its cost is $400 - 500 if installed together with the boiler.

6.0 INTERIM COMMENTS

The recouperative furnace has been operating satisfactorily, with no functional problems to report. However, some problems did arise as a result of an improper installation of the vent line.

The male end of an adjustable, slip-joint section of the vent line was installed away from the furnace, rather than facing towards it as suggested in the manufacturer's installation manual. Although sealed with the recommended silicon sealant, eventually leaks of condensate developed, dripping on the top of the furnace cabinet. The problem was left unattended for two months to see the extent of the consequences. It resulted in condensate dripping inside the cabinet, in the burner area, over the gas valve and over some wiring (both low and high voltage).

The implication here is that with higher efficiency systems, strict adherence to manufacturer's instructions is essential and that heating contractors should acquire complete familiarization with the particular units installed.

At the vent outlet from the furnace there is a mild steel flange, used to attach the stainless steel vent line and to collect and drain condensate from the vent line before it reaches the vent blower housing. this collector flange started to corrode as a result of the condensate dripping. This item must be corroding on the inside as well and, although it is hefty for long life, rust particles might eventually cause some problems if, for example, they ever find their way to a pressure switch. Further investigation will follow.

The manufacturer of the recouperative furnace have had instances of corrosion related failures of the vent line, with the development of pinholes and pitting in the presence of significant quantities of halogenated compounds in the combustion air (eg. from bleach). As reported in specialized literature (Ref. 1), they offer to substitute at no cost the complete vent line (originally stainless steel 304) with one of proprietary alloy (Allegheny - Ludlum 29-4C) less susceptible to attack by halogens. In their view, the failures never posed any safety hazards, given the small amounts of escaping combustion products involved.

Its steady state efficiency was measured at over 85%.

To the complete satisfaction of the homeowner, the high efficiency non-condensing furnace has been operating flawlessly for a few months, with nothing relevant to report. Steady state efficiency was measured at around 84%.

This unit employs a continuous length of flexible stainless steel tubing for venting the flue products. This both simplifies installation and minimizes the possibility of combustion products leakage from the pressurized vent line, which must be pitched towards the furnace.

The combination boiler and domestic hot water heater is a sealed combustion unit with concentric inlet and outlet pipes, which allows for some combustion air preheating. Steady state thermal efficiency was measured at 88%.

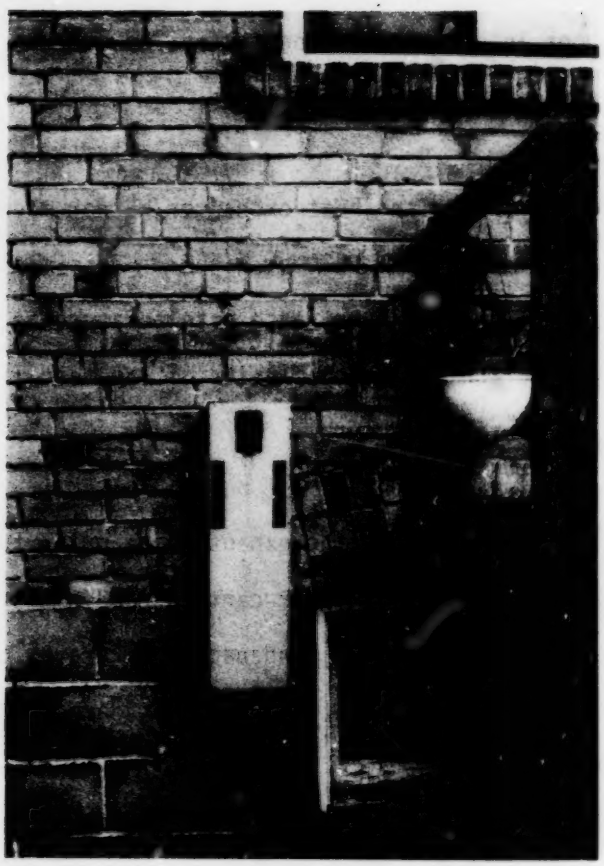
The unit is easy to install, but needs care to ensure that the vent is outward sloping and for the installation of accessories like pressure relief valves and tempering valves. In fact a pressure relief valve was damaged through overheating, while soldering in a tight spot.

This unit is not intended to be condensing, however the following should be noted:

- condensation inside the heat exchanger/burner module is avoided by keeping stored water at 60°C or higher. This means that the exchanger coil surfaces should never reach a temperature below the dew point. A visual inspection at the conclusion of the test will give clues as to whether condensation occurs.

- flue gases are cooled in the exhaust line prior to venting by incoming outside combustion air. Under certain conditions of low ambients, condensation may occur and condensate may travel back if installation instructions (requiring <u>outward</u> pitching) are not followed properly.

- condensate does occur when an external riser (Figure 12) is used and in fact drainage holes are provided. Under extreme weather conditions, considerable amount of ice build-up forms between the riser and the ground. In itself this may only be a nuisance, but the presence of condensate in a mild steel riser raises serious questions about its expected life. This point will be further investigated.



HEATMAKER VENT TERMINAL - EXTERNAL RISER VERSION

FIG. 12

The presence of a relatively high temperature (60 - 80°C) mass of water may set-up gravity induced flow through the hydronic circuit. This happened in our test site and the problem was eventually solved by installing a solenoid valve, later substituted with a motorized valve which has a more desirable progressive action. The manufacturer recommends a flow check valve in the supply line. However, since flow could take place in either direction, a check valve would be ineffective.

To minimize thermal convection between the tank and the external piping, the manufacturer recommends that all heating and domestic hot water piping to the unit be made with a vertical thermal leg (heat trap) extending at least 15 cm down from the point of connection. We did that and also insulated all water pipes with foam sheeting, for five to ten feet away from the unit. As per instructions, a tempering valve (set at 60°C) was installed in the domestic hot water line. This reduces the possibility of scalding and limits hot pipe losses (negative in summer).

7.0 INTERIM CONCLUSIONS AND RECOMMENDATIONS

1. Householders of the three test sites are satisfied with the functional operation of the units under test.

2. Heating contractors must familiarize themselves with the manufacturer's installation instructions on varying requirements for condensate drainage, venting, etc. (eg. the two furnaces under investigation require upwards pitching of the vent line, while the vent from the combination appliance must slope down away from the unit). Reduced standardization reflects the different techniques adopted to achieve higher operating efficiencies.

3. Insulation of water pipes connected to the combination unit should be carried over the manufacturer's recommendation of insulating from the unit to the vertical legs of the heat traps, to effectively reduce heat losses.

4. The sectional vent line of the recouperative unit is more sensitive to proper installation procedures, to avoid leakage of condensate. A continuous length of flexible corrugated tubing would be preferable, however, the long term effect of condensate pockets trapped in the ripples would have to be carefully investigated. A combination of shallow corrugation and adequate slope of horizontal runs might be a good answer.

LIST OF REFERENCES

1. Air Conditioning, Heating & Refrigeration News, Pg. 1, April 18, 1983.

APPENDIX "A"

HOMEOWNER QUESTIONNAIRES

HOMEOWNER QUESTIONNAIRE

SITE: "A" (FIG. 6)

GENERAL INFORMATION

Name of occupant V. REID

Installation address 322 BAIN STREET, TORONTO

Single Family Residence? YES Multiple? _____

Approx. age of structure 40+ How long have you resided? _____

No. of occupants THREE Adults TWO How many are employed? TWO

If two or more, which hours 9 - 5

What indoor temperatures do you maintain:

While at work 19°C Hours _____

Daytime 19°C Hours _____

Nightime 19°C Hours _____

STRUCTURE

Number of stories THREE Floor area 159 m^2

Type of construction (Brick or frame) FRAME Style SEMI-DETACHED

Does it have storm windows YES Storm doors YES

Is it insulated YES Was any insulation installed recently _____

If so, when _____ Where, and thickness _____ Type _____

In your opinion, is building of tight construction? AVERAGE

Do you have a basement YES Is it heated YES

No. of basement windows THREE Do they close tightly? YES

Is the door to the basement normally closed YES

No. of exhaust fans: Kitchen _____ Bathroom ONE Other _____

Where is thermostat located (room) LIVING Inside or Outside Wall INSIDE

Does this house have a fireplace YES Does it have a good damper YES

APPLIANCES

Does this residence have a gas light? NO

Input or number of mantles _____

Does this residence have an electric or gas range GAS

If Gas: Type _____ Location KITCHEN

...cont'd

HOMEOWNER QUESTIONNAIRE CONT'D

APPLIANCES CONT'D

Does this residence have a gas grill? NO

Hourly inputs _____ How often is it used? _____ _____

Does this residence have a gas or electric clothes dryer ELECTRIC

If gas: Location _____ Vented to outdoors? _____

Size of vent pipe _____ Hourly input _____

How often is it used? _____

Does this residence have a gas fired water heater YES

Storage capacity 40 USG Hourly input 9.7 kW (34.8 MJ/h)

Size of flue pipe 100 MM Does this pipe connect to the same chimney as the heating system YES

Does this residence have air conditioning? NO

Central _____ Window units _____ How many? _____

HEATING SYSTEM

Present Furnace/Boiler:

Trade Name MODERN GAS FURNACE

Model _____

Manufacturer _____

Rated Input 29.3 kW (105 MJ/h)

Age 10+ YEARS

Type of Ignition PILOT

Type of Venting NATURAL DRAFT

Test Furnace/Boiler:

Trade Name RECOUPERATIVE FURNACE

Model UR 085D16

Manufacturer ARKLA

Rated Input 24.9 kW (89.6 MJ/h)

Age NEW

Type of Ignition SPARK, INTERMITTANT PILOT

Type of Venting POWER (INDUCED)

TEST CHANGES:

HOMEOWNER QUESTIONNAIRE

SITE: "B" (FIG. 7)

GENERAL INFORMATION

Name of occupant P. HARPER

Installation address 31 FALCON ST., TORONTO

Single Family Residence? YES Multiple? _____

Approx. age of structure 60+ How long have you resided? 4 YEARS

No. of occupants 3 Adults 2 How many are employed? 2

If two or more, which hours 9 - 5

What indoor temperatures do you maintain:

While at work 19°C Hours _____

Daytime 19°C Hours _____

Nightime 19°C Hours _____

STRUCTURE

Number of stories TWO Floor area 159 m^2 (TOTAL)

Type of construction (Brick or frame) 1st-brick 2nd-frame Style SEMI-DETACHED

Does it have storm windows YES Storm doors YES

Is it insulated SOME Was any insulation installed recently YES

If so, when 1981 Where, and thickness CEILING Type BLOWN FIBREGLASS

In your opinion, is building of tight construction? AVERAGE (LEAKY WINDOWS)

Do you have a basement YES Is it heated YES

No. of basement windows 3 Do they close tightly? YES

Is the door to the basement normally closed OPEN (NO DOOR)

No. of exhaust fans: Kitchen NA Bathroom NA Other NA

Where is thermostat located (room) LIVING Inside or Outside Wall INSIDE

Does this house have a fireplace YES Does it have a good damper YES

APPLIANCES

Does this residence have a gas light? NO

Input or number of mantles _____

Does this residence have an electric or gas range ELECTRIC

If Gas: Type _____ Location _____

...cont'd

HOMEOWNER QUESTIONNAIRE CONT'D

APPLIANCES CONT'D

Does this residence have a gas grill? NO

Hourly inputs _____ How often is it used? _____

Does this residence have a gas or electric clothes dryer GAS

If gas: Location BASEMENT Vented to outdoors? YES

Size of vent pipe 10 MM Hourly input _____

How often is it used? THREE TIMES/WEEK

Does this residence have a gas fired water heater YES

Storage capacity 40 USG Hourly input 9.7 kW (34.8 MJ/h)

Size of flue pipe 100 MM Does this pipe connect to the same chimney as the heating system YES

Does this residence have air conditioning? NO

Central _____ Window units _____ How many? _____

HEATING SYSTEM

Present Furnace/Boiler:

- Trade Name CLARE HARKLA
- Model ? (OIL FURNACE)
- Manufacturer _____
- Rated Input 39.5 kW (142.4 MJ/h)
- Age 15 YEARS
- Type of Ignition _____
- Type of Venting _____

Test Furnace/Boiler:

- Trade Name CONCEPT 2000
- Model P9UED11
- Manufacturer YORK HTG & A/C
- Rated Input 23.4 kW (84.4 MJ/h)
- Age NEW
- Type of Ignition SPARK (INTERMITTENT PILOT)
- Type of Venting POWER VENTED (INDUCED DRAFT)

TEST CHANGES:

HOMEOWNER QUESTIONNAIRE

SITE: "C" (FIG. 8)

GENERAL INFORMATION

Name of occupant J. OTSASON

Installation address 261 JOICEY BLVD, TORONTO

Single Family Residence? YES Multiple? _____

Approx. age of structure 38 YEARS How long have you resided? 4 YEARS

No. of occupants ONE Adults _____ How many are employed? ONE

If two or more, which hours _____

What indoor temperatures do you maintain:

While at work 13°C Hours 7 a.m. - 4:30 p.m.

Daytime 20°C Hours 5:20 p.m. - 10 p.m.

Nightime 18°C Hours 10 p.m. - 5:30 a.m.

STRUCTURE

Number of stories 1 1/2 Floor area 102 m^2 (EXCLUDING BASEMENT)

Type of construction (Brick or frame) SOLID BRICK Style 1 1/2 STOREY CAPE COD

Does it have storm windows YES Storm doors YES

Is it insulated YES Was any insulation installed recently YES

If so, when 1981 Where, and thickness ATTIC R-30 ~~HALF BASEMENT~~ R-12 Type FIBREGLASS BAT.

In your opinion, is building of tight construction? AVERAGE

Do you have a basement YES Is it heated YES

No. of basement windows FIVE Do they close tightly? YES

Is the door to the basement normally closed OPEN

No. of exhaust fans: Kitchen ONE Bathroom ONE Other -

Where is thermostat located (room) LIVING Inside or Outside Wall INSIDE

Does this house have a fireplace YES Does it have a good damper NOT USED

APPLIANCES

Does this residence have a gas light? NO

Input or number of mantles _____

Does this residence have an electric or gas range ELECTRIC

If Gas: Type _____ Location _____

...cont'd

HOMEOWNER QUESTIONNAIRE CONT'D

APPLIANCES CONT'D

Does this residence have a gas grill? YES

Hourly inputs 11.7 kW(42.2 MJ/h) How often is it used? 3 TIMES/WEEK

Does this residence have a gas or electric clothes dryer ELECTRIC

If gas: Location _____ Vented to outdoors? _____

Size of vent pipe _____ Hourly input _____

How often is it used? _____

Does this residence have a gas fired water heater NO

Storage capacity _____ Hourly input _____

Size of flue pipe _____ Does this pipe connect to the same chimney as the heating system _____

Does this residence have air conditioning? YES

Central _____ Window units YES How many? ONE

HEATING SYSTEM

Present Furnace/Boiler:

Trade Name POTTERTON

Model ? INSTANT GAS BOILER

Manufacturer POTTERTON

Rated Input 23.4 kW (84.4 MJ/h)

Age 3 YEARS

Type of Ignition SPARK IGNITION PILOT

Type of Venting POWER, SEALED COMBUSTION

Test Furnace/Boiler:

Trade Name HEATMAKER

Model BGP-100 HW

Manufacturer BGP SYSTEMS INC.

Rated Input 29.3 kW (105.5 MJ/h)

Age NEW

Type of Ignition GLOW, DIRECT

Type of Venting POWER, SEALED COMBUSTIC

TEST CHANGES: